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(54) **REGRIND POLYURETHANE WITH GLYCOL OR POLYOL ADDITIVE**

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A43B 3/00	(2006.01)
C08G 18/83	(2006.01)
A43B 1/00	(2006.01)
B29B 17/00	(2006.01)

(52) **U.S. Cl.**

CPC . ***C08K 5/053*** (2013.01); ***A43B 1/00*** (2013.01); ***A43B 1/12*** (2013.01); ***A43B 3/0078*** (2013.01); ***B29B 17/0005*** (2013.01); ***C08G 18/831*** (2013.01); *Y02W 30/683* (2015.05)

(58) **Field of Classification Search**

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USPC 521/49, 49.5; 523/167; 264/37.3; 524/386

See application file for complete search history.

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(57) **ABSTRACT**

A surface element including a recycled polyurethane and a glycol or polyol additive is provided. The surface element has an increased tearability as compared to the recycled polyurethane. An article of footwear and methods of preparing an article of footwear are also provided.

24 Claims, 1 Drawing Sheet

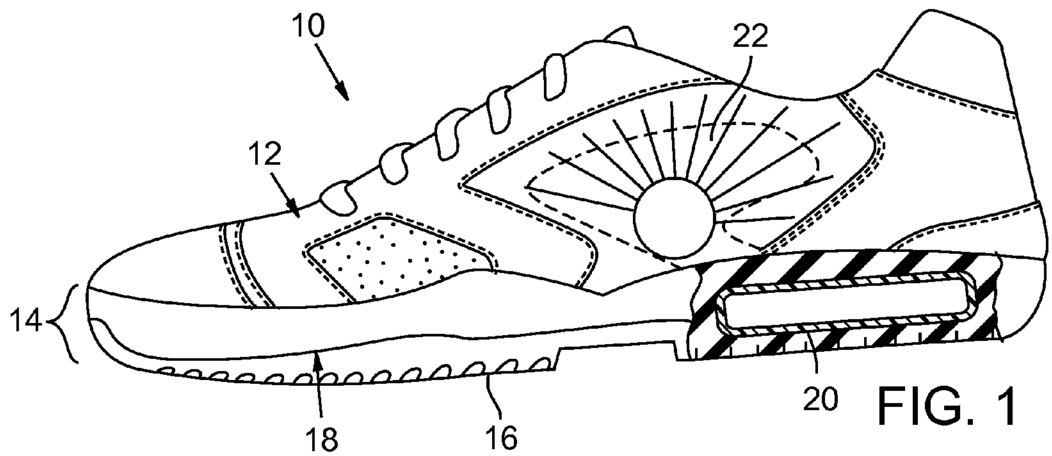

FIG. 1

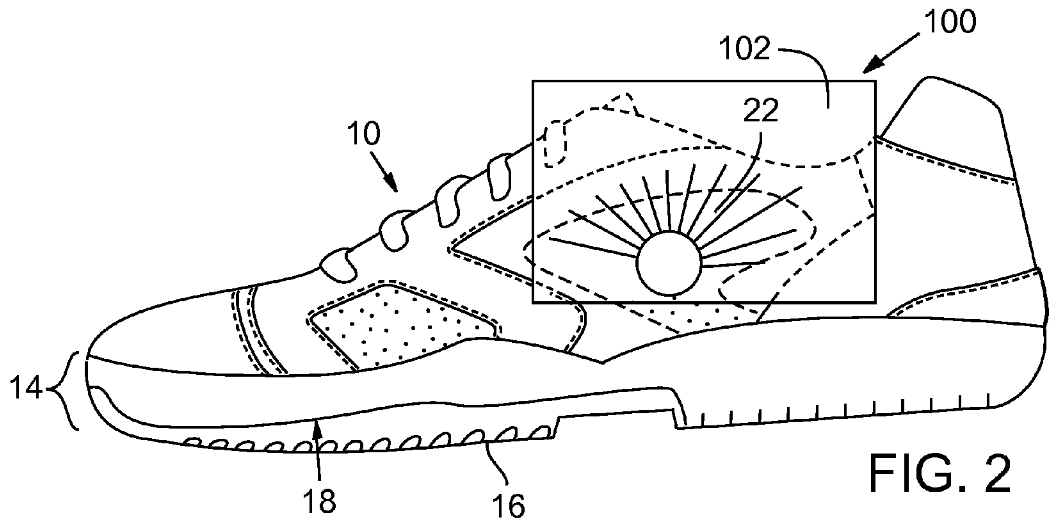

FIG. 2

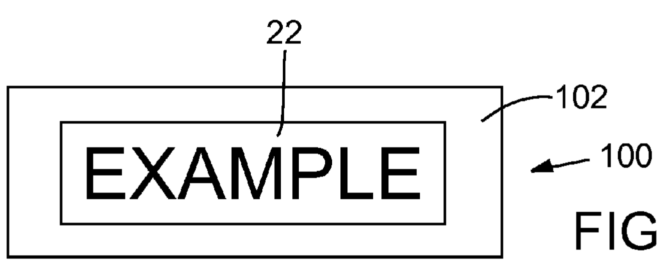

FIG. 3

REGRIND POLYURETHANE WITH GLYCOL OR POLYOL ADDITIVE

This application is a 371 U.S. National Stage of International Application No. PCT/EP2010/001479, filed Sep. 25, 2010, the disclosure of which application is incorporated in this specification by reference.

FIELD

The present disclosure relates to methods of recycling polyurethane, and more particularly to methods of incorporating regrind thermoplastic polyurethane into a surface element.

BACKGROUND

This section provides background information related to the present disclosure which is not necessarily prior art.

A significant problem in the production and use of polyurethane resins is the disposal of thermally degraded and/or off-grade, polyurethane resins. For example, when a thermoplastic polyurethane (TPU) material is incorporated into various products or used to form products, waste material is generated. The waste material includes fully or partially thermally degraded resins, misformulated resins, or scrap resins. Much of the waste material with polyurethane in sheet form is the scrap edges from polyurethane materials that have been shaped using a mold. Although many efforts have been made to shape molds to minimize waste, the nature of using sheets of TPU necessarily generates scrap edges.

In prior systems, the waste material was discarded because it was not suitable for use in the original product. In still other systems, the scrap resin or misformulated resins was separated into small pieces, to form regrind, and the regrind was blended with virgin resin and used in the same application. Regretfully, only a limited amount of regrind can be used without sacrificing the desired properties of the particular polyurethane resin for the application.

Using regrind to provide different parts of an item or for use in a new item would reduce the need to create virgin thermoplastic polyurethane. Modifications to regrind use would provide alternatives to allow the scrap polyurethane from one component of a product to be used in a different component of the product or in a different product. Such modifications are environmentally friendly, beneficial in a production line, increase cost-effectiveness, minimize downtime and loss of plant resources, and minimize the need to produce and purchase virgin materials.

SUMMARY

This section provides a general summary of the disclosure, and is not comprehensive of its full scope or all of the disclosed features.

In various aspects, the present teachings provide a surface element including a recycled polyurethane and a glycol or polyol additive. The surface element has an increased tearability as compared to the recycled polyurethane.

In other aspects, the present teachings provide an article of footwear including: an upper, a midsole, an outsole, and a surface element. The surface element includes a recycled polyurethane and a glycol or polyol additive. The surface element has a melt index that is at least about three-fold greater than the melt index of the recycled polyurethane.

In still further aspects, the present teachings provide methods of preparing footwear having a surface element. A scrap polyurethane is collected from a shoe component. The scrap polyurethane has a first melt index and a first tearability. The scrap polyurethane is mixed with a glycol or polyol additive. The first melt index of the scrap polyurethane is increased. A sheet is formed of the polyurethane and glycol or polyol additive mixture. The sheet is applied to an outer region of an article of footwear. A perimeter of the sheet is torn to form the surface element.

DRAWINGS

The drawings described herein are for illustrative purposes only of selected embodiments and not all possible implementations, and are not intended to limit the scope of the present disclosure.

FIG. **1** depicts an article of footwear according to various aspects of the present teachings;

FIG. **2** depicts a surface element being applied to an article of footwear according to various aspects of the present teachings; and

FIG. **3** depicts a sheet of material having a surface element according to various aspects of the present teachings.

Corresponding reference numerals indicate corresponding parts throughout the several views of the drawings.

DETAILED DESCRIPTION

Example embodiments are provided so that this disclosure will be thorough, and will fully convey the scope to those who are skilled in the art. Numerous specific details are set forth such as examples of specific components, devices, and methods, to provide a thorough understanding of embodiments of the present disclosure. It will be apparent to those skilled in the art that specific details need not be employed, that example embodiments may be embodied in many different forms and that neither should be construed to limit the scope of the disclosure. In some example embodiments, well-known processes, well-known device structures, and well-known technologies are not described in detail.

The terminology used herein is for the purpose of describing particular example embodiments only and is not intended to be limiting. As used herein, the singular forms "a," "an" and "the" may be intended to include the plural forms as well, unless the context clearly indicates otherwise. The terms "comprises," "comprising," "including," and "having," are inclusive and therefore specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. The method steps, processes, and operations described herein are not to be construed as necessarily requiring their performance in the particular order discussed or illustrated, unless specifically identified as an order of performance. It is also to be understood that additional or alternative steps may be employed.

In various embodiments, the illustrations of the present teachings relate to an article of footwear **10** as shown in FIG. **1**. Generally, the article of footwear **10** includes an upper **12** and a sole assembly **14**. The sole assembly **14** is attached to the upper **12** and can include an outsole **16** and a midsole **18**. Optionally, the midsole **18** can include a bladder **20**. The article of footwear **10** is depicted with an exemplary surface element **22**.

While the illustrations and figures relate to an article of footwear, it is understood that the materials and methods detailed are also applicable to apparel such as shirts, patents, hats, gloves, and the like and also to sports equipment including balls, bats, masks, racquets, backboards, nets, and the like, as non-limiting examples.

Referring to FIGS. **1-3**, examples of the surface element **22** are shown. The surface element **22** is also known as surface indicia, features, embellishments, or decorations, as non-limiting examples. The surface element **22** is made of a recycled polyurethane and a glycol or polyol additive. The surface element **22** has an increased tearability (or decreased tear resistance) as compared to the unmodified recycled polyurethane. "Tear resistance" and conversely, "tearability" as used herein can be defined and measured as set forth in ASTM D1004, incorporated by reference in its entirety. The increased tearability allows the surface element **22** to be shaped, torn, or cut without exerting a high force. For example, the increased susceptibility to tearing allows the surface element **22** to be torn by hand or easily removed by a machine without necessarily requiring a sharp die cutting tool or elaborate machinery. The increased tearability is selected to allow shaping and application of the surface element **22** without compromising its desired strength or durability.

The surface element **22** is any of a text, design, logo, mascot, or theme, as non-limiting examples. In various embodiments, the surface element **22** is made of a single color, finish, or pattern, or various combinations thereof. As shown in FIG. **1**, the surface element **22** is an image of the sun while the example in FIG. **3** is text.

The source polyurethane is a scrap or spare material. The source polyurethane includes either a virgin material or material that has been recycled at least one time. As a non-limiting example, the source material traditionally would have been discarded because of a lack of apparent or easy re-use without cumbersome steps or significant costs. The present teachings help to eliminate this waste and provide an environmentally friendly alternative and cost-efficient use for the scrap or spare material.

In various embodiments, the polyurethane is sourced from the same material as the subject item (for example, from a component of an article of footwear), or the polyurethane is sourced from a different material wholly separate from the subject item, such as with a cross-industrial use (for example, a scrap material from an automotive component being recycled and incorporated into a home furnishing element). In various embodiments, the scrap or recycled polyurethane provides all of the source polyurethane in the system. In other embodiments, the polyurethane can be a mix of virgin and recycled materials. Such examples could include from about 5% to about 99% by weight or from about 55% to about 99% by weight of the recycled materials with the remainder of the urethane being a virgin material.

In various embodiments, the source polyurethane is a thermoplastic polyurethane. The thermoplastic urethane is either an ester- or ether-based urethane. Others polyurethanes include those selected from the group consisting of polyester, polyether, polycaprolactone, polyoxypropylene, and polycarbonate macroglycol based materials, and mixtures thereof. In various embodiments, the recycled polyurethane is formed of any polyurethane or a methylene diphenyl diisocyanate (MDI) or diisocyanate (DI) derivative. Among the useful isocyanates and diisocyanates in the source polyurethane include, but are not limited to, isophorone diisocyanate (IPDI), methylene bis 4-cyclohexyl isocyanate (H_{12}MDI), cyclohexyl diisocyanate (CHDI), hexamethylene diisocyanate (HDI), m-tetramethyl xylene diisocyanate (m-TMXDI), p-tetramethyl xylene diisocyanate (p-TMXDI), and xylylene diisocyanate (XDI).

The source polyurethane is optionally cut or ground to form smaller particles for processing. Such materials are commonly known as regrind. The size of the regrind is selected for convenience, to achieve appropriate melting properties when the regrind is processing, or in light of the reaction parameters. In various embodiments, the source polyurethane is a combination of polyurethanes having different Shore hardnesses. For example, a mix of two polyurethanes having a Shore hardness of 65A and a Shore hardness of 85A, respectively, is employed in various embodiments. A mixture of polyurethanes having different Shore hardnesses further modulates the melt index of the surface element **22**.

The recycled or regrind polyurethane has a starting melt index and tearability. Generally, the source polyurethane has a high melt index of up to 20, which would be lower than the melt index of the surface element **22** formed therefrom. The Examples provided later herein further illustrate the increase in melt index and tearability according to the present teachings.

In various embodiments, the glycol additive that is combined with the regrind or recycled polyurethane is selected from 1,4-butanediol, 1,3-butanediol, dipropylene glycol, 1,4-cyclohexane dimethanol, or tripropylene glycol. Similarly, any other difunctional alcohol or chain extenders, and combinations thereof, are able to be employed in the present teachings. Particular examples of such materials include, without limitation, ethylene glycol, diethylene glycol, and higher polyethylene glycol analogs like triethylene glycol; propylene glycol, and higher polypropylene glycol analogs like tripropylene glycol and tetrapropylene glycol; 1,3-propanediol, 1,6-hexanediol, 1,7-heptanediol, neopentyl glycol, dihydroxyalkylated aromatic compounds such as 4,4'-isopropylidene diphenol, (bisphenol A), resorcinol, catechol, hydroquinone, benzenedimethanols, the bis(2-hydroxyethyl) ethers of hydroquinone and resorcinol; p-xylene-α,α'-diol; the bis(2-hydroxyethyl)ether of p-xylene-α,α'-diol; m-xylene-α,α'-diol and the bis(2-hydroxyethyl) and alkylene oxide adducts of such diols. Other candidates include glycerin, trimethylol propane, neopentyl glycol, and the like. Further, low molecular weight polyols formed by the reaction of a glycolic extender and a diacid such that the resulting polymer has a molecular weight below about 500 are also suitable. A single glycol or polyol additive or a plurality of different glycol additives and/or polyol additives is combined with the regrind polyurethane in the present teachings.

The glycol or polyol additive is added in a limited amount to the regrind polyurethane. Generally, the glycol or polyol additive is provided in an amount of less than about 10% by weight. In further embodiments, the glycol or polyol additive is added in an amount of about less than 5% by weight down to an amount of less than about 1% by weight. In preferred embodiments, the glycol or polyol is a liquid at room temperature to facilitate metering, however, low melting solids (120 degrees C. or less) are also successfully employed in the present teachings. In embodiments where the glycol or polyol has a relatively high boiling point, such as with tripropylene glycol and 1,4 cyclohexanedimethanol, fuming during processing and the formation of deposits on metal rolls during extrusion are reduced.

The amount of glycol or polyol added will provide the appropriate increase in flow rate and melt index for the particular combination of the glycol or polyol additive and the regrind polyurethane. In various embodiments, the amount of the glycol or polyol additive added is sufficient to provide a melt index of from about 50 to about 300, or a melt index that is several fold higher than the source polyurethane. It is believed that the melt index increases due to the glycol or polyol additive serving as a chain extender. This decreases the molecular weight of the resultant urethane which in turn increases flow and tearability.

An example method of measuring the melt index is provided in ASTM D1238, incorporated by reference in its entirety. Further, the addition of the glycol or polyol additive to the regrind polyurethane will decrease the molecular weight of the modified polymer as compared to the molecular weight of the starting recycled polyurethane.

Optionally, additional additives can be employed including, but not limited to, pigments, various stabilizers, flame retardants, wax, antioxidants, etc. For example, if added various plasticizers would increase the flexibility and durability of the final product as well as facilitate the processing of the material from a resinous form to a membrane or sheet useful for a surface element. Fillers are also optionally included, such as fibrous and particulate materials, non-polar polymeric materials and inorganic anti-block agents. Still other additives or processing aids are optionally included such as mold release agents and lubricants, as are known in the art. Any of these additives are either provided with the source polyurethane or are added at a different processing step. It is understood that the additives will not significantly alter the desired melt index and ease of tearing for the surface element **22**. It is understood that combinations of the additives allow for customization of color and texture, for example, of the surface element **22**.

As illustrated in the Examples, the surface element **22** may have a melt index that is at least about three-fold greater than the melt index of the source regrind polyurethane. In various embodiments, the surface element **22** has a melt index of at least 100 grams/10 minutes at 190 degrees C./8700 sec. The higher melt index as compared to that of the source polyurethane indicates a better propensity to flow and facilitates more easily applying the surface element **22** to the underlying substrate.

According to various embodiments of the present teachings, methods of preparing a surface element **22** for an article of footwear **10** are provided. To prepare the surface element **22**, source polyurethane, for example, at least partly from scraps of a shoe component (bladder, sole, upper, etc.) is used.

As detailed above, the source material is a polyurethane regrind that has a starting Shore A hardness and a melt index. If desired, the hardness of the source polyurethane can be reduced by blending it with a softer polyurethane. Also, if desired, a small amount of a virgin polyurethane (10% or less by weight) is added.

The glycol or polyol is then added in the desired amount, preferably less than about 10% by weight. In some embodiments, the polyurethane stream and glycol or polyol are processed on a twin screw extruder by adding the latter via a metering pump. The polyurethane stream is added via a loss in weight feeder that allows a constant ratio between the two materials to be maintained. In other embodiments, the glycol or polyol is added to the feed throat, to a downstream port, or into the melt via an injector, for example. The extruder output is optionally either strand pelletized or pelletized via an underwater pelletizer or other methods well known to the art. In such embodiments, the melting and mixing of the two ingredients is controlled by process conditions and the twin screw extruder feed is less affected by the lubricating effect of the glycol or polyol addition. Additives such as those listed above are optionally added during the compounding process.

In still other embodiments, the glycol or polyol is added to the polymer as a master batch that can be made in a non-fluxing batch mixer by spraying the glycol or polyol from a number of nozzles that are fed by a metering pump. The source polyurethane absorbs up to about 5% of glycol or polyol and forms a free flowing mix. The absorption process is sped up by warming the mix to a suitable temperature, for example to about 80 degrees C. Regrind is particularly suited for such processes because the irregular shape of regrind particles speeds up the absorption of the glycol or polyol. The regrind that has absorbed the glycol or polyol is run through an extruder if it contains the correct amount of glycol or polyol, or it can be treated as a master batch and be blended with source polyurethane that does not contain glycol or polyol, for instance. This minimizes heat addition and slippage of the polyurethane during the single screw extrusion.

Yet another addition method is to simply pump the glycol or polyol from a metering pump into the feed throat of the extruder using an injection port in the barrel or an injection port on the screw. The ratio of glycol or polyol to polyurethane is controlled, such as by using a metering pump and screw speed as known in the art.

With reference to FIGS. **2** and **3**, regardless of the technique selected, in various embodiments, the materials provide a sheet **100** or another suitable shape. The sheet **100** or a region of the sheet is applied to an outer region of the article of footwear **10**. The footwear **10** can be assembled when the surface element **22** is applied, as illustrated, or the surface element can be applied to a distinct component of the article of footwear **10** prior to assembly thereof. In various embodiments, the sheet **100** is either pre-formed in a particular shape such that no extra surface element material is used, or the sheet is a universal shape. The surface element **22** is applied to the region of the article of footwear **10** and the perimeter **102** of the sheet outside of the weld lines about the desired shape (or surface element **22**) is removed. In such embodiments, the perimeter **102** of the sheet **100** is removed to form the surface element **22**. The melt index allows the perimeter **102** to be ripped cleanly away around the weld without disturbing the surface element fixed to the article of footwear **10**. Any scrap material from the sheet **100** can be recycled or reused to form other areas of a surface element **22**. In various embodiments, the sheet **100** optionally includes perforations (not shown) to facilitate easy removal of the surface element **22**.

The surface element **22** is fixed to the article of footwear **10**. Application methods include RF welding, heat transfer, laminating, and the like. The surface element **22** is able to be applied to any of the upper **12**, midsole **18**, or outsole **16** of the article of footwear **10**. The article of footwear **10** includes any type of shoe, boot, or sandal. In various embodiments, the article of footwear **10** is an athletic shoe.

In various embodiments, the sheet **100** includes a plurality of surface elements **22**. In such embodiments, the surface elements **22** can be placed along different areas of an article of footwear **10** or on different articles of footwear **10**. Providing the sheet **100** with the plurality of surface elements **22** makes the system more cost-effective and further minimizes generation of scrap materials.

As detailed above, the surface element **22** can also be applied to apparel and/or sports equipment. In such embodiments, the application methods can be modified to include stitching, in addition to the above application methods. The application conditions, such as temperature and amount of pressure exerted, are modified for the respective substrate.

The following Examples provide illustrations of the present teachings.

EXAMPLES

A thermoplastic polyurethane (TPU) sheet was produced that was approximately 3 feet wide, having different gauges, and showing either smooth/fine matte or matte/fine matte finishes. The feed was an ester-based thermoplastic polyurethane regrind derived from methylene diphenyl diisocyanate (MDI) that had a Shore hardness of 90A and a melt index of 9.4 grams/10 minutes at 190 degrees C./8700 grams. Also, 4% of a TPU concentrate that contained a UV stabilizer and a small amount of a blue tint were included in the mixture. The sheet was processed on a 3.5 inch extruder equipped with a 3-roll stand. 1,4-butanediol (BDO) was added via a metering pump to the extruder feed throat. The amount of BDO added was a few tenths of a percent. As shown in Table 1, the final sheet tested and labeled Samples 1-10 had melt indexes of from about 30 to 60 grams/10 minutes at 190 degrees C./8700 grams. The melt index of the control sheet extruded from a similar regrind without the BDO was only 16 grams/10 minutes at 190 degrees C./8700 grams, also shown in Table 1.

TABLE 1

Sample Number	Finish	Thickness mm	Melt Index (190 C./8700)	Direction	TS psi	Percent Elongation	Modulus at: 50% psi	100% psi	200% psi	300% psi	Die C (pli)
1	matte/fine matte	0.3	51	machine direction	12160	541	1123	1314	1862	3629	782
				transverse direction	11976	598	1051	1207	1586	2719	807
2	matte/fine matte	0.5	31	machine direction	9912	551	1055	1228	1660	2947	717
				transverse direction	10161	561	858	986	1356	2597	726
3	matte/fine matte	0.7	59	machine direction	8948	564	977	1135	1449	2319	680
				transverse direction	8702	530	924	1951	1401	2592	704
4	matte/fine matte	0.8	42	machine direction	8744	526	1038	1171	1588	2871	676
				transverse direction	8058	567	951	1063	1405	2394	687
5	matte/fine matte	1	40	machine direction	10638	578	1090	1239	1657	2730	660
				transverse direction	10302	572	1104	1235	1645	2821	674
6	smooth/fine matte	0.3	51	machine direction	12284	594	1181	1384	1869	3103	770
				transverse direction	10022	612	1015	1176	1571	2837	773
7	smooth/fine matte	0.5	40	machine direction	9934	487	1087	1331	2027	3874	725
				transverse direction	9669	592	944	1079	1360	2285	790
8	smooth/fine matte	0.7	31	machine direction	8758	542	906	1063	1456	2469	642
				transverse direction	8661	563	1033	1157	1482	2513	649
9	smooth/fine matte	0.8	44	machine direction	9375	586	984	1140	1458	2293	678
				transverse direction	8961	572	955	1078	1367	2222	674
10	smooth/fine matte	1	42	machine direction	8391	607	866	982	1274	2111	665
				transverse direction	7875	573	869	975	1254	1997	645
control sheet without BDO	matte/matte	1	16	machine direction	8336	520	1076	1290	1799	3108	687
				transverse direction	8407	519	1030	1194	1610	2846	693

As shown in Table 2, Samples 11-18 contained either 2% or 5% BDO in a TPU regrind with a melt index ranging for 8 to 20 grams/10 minutes at 190 degrees C./8700 grams. Samples 11-18 were prepared according to Table 2 by mixing the respective BDO and TPU regrind in a non-fluxing mixer run at 80 degrees C. Different amounts of the samples were combined with regrind that was free of 1,4-butanediol and then extruded into sheet. The TPU regrind was ester-based and had a melt index of 20 grams/10 minutes at 190 degrees C/8700 grams. As shown in Table 3, the melt index of Samples 11-18 increased multiple-fold with increasing amounts of 1,4-butanediol.

TABLE 2

Sample Number	Percent of 2% BDO Additive	Percent of 5% BDO Additive	Percent of BDO in feed	Melt Index in grams/10 minutes 190 C. 8700 grams
11	5	—	0.1	54
12	7.5	—	0.15	40
13	—	2	0.1	54

TABLE 2-continued

Sample Number	Percent of 2% BDO Additive	Percent of 5% BDO Additive	Percent of BDO in feed	Melt Index in grams/10 minutes 190 C. 8700 grams
14	—	3	0.15	68
15	25	—	0.5	64
16	—	10	0.5	80
17	—	16	0.8	140
18	—	20	1	110
control	none	none	0	30

As shown in Table 3, the melt index of Samples 11-18 increased with increasing amounts of 1,4-butanediol. Notably, Sample 18 contained 1% BDO in the feed and had a Die C tear strength of only 564 pounds/inch. Sample 15, for example, contained 0.5% BDO in the feed and had a Die C tear strength of 693.5 pounds/inch. To the contrary, the control without any BDO had a Die C tear Strength of 722.5 pounds/inch. This demonstrates that the increase in BDO concentration decreases the tear strength (or conversely increases the ease of tearing).

TABLE 3

Sample Number	MI	Tensile strain, psi	Failure strain, percent	Modulus at 50%, psi	Modulus at 100%, psi	Modulus at 200%, psi	Modulus at 300%, psi	Die C Tear Strength (lb/in)
11	54	8560	557	990.5	1170	1590	2660	674.5
12	40	9415	548	1090	1290	1765	3025	762.5
13	54	8435	532.5	1006.5	1165	1515	2495	692.5
14	68	8215	532.5	1060	1215	1615	2645	676.5
15	64	8210	509.5	1045	1215	1600	2655	693.5
16	80	8575	573.5	1130	1285	1610	2500	739
17	140	5100	496	970	1075.5	1265	1740	600.5
18	110	6650	561	916	1016.5	1225	1845	564
control	30	9860	523.5	1139.5	1340	1880	3395	722.5

As shown in Table 4, Samples 21-25 were prepared from a 90A ester-based regrind and/or a 75A ester based TPU, both of which were derived from MDI. A 90A ester based TPU regrind infused with 4% of 1,4 BDO was added to the respective materials. The melt index of the regrind was 8-20 grams/10 minutes at 190 degrees C./8700 sec. The test was performed on a 3.5 inch extruder equipped with a melt pump and a 3-roll stand. The blends were extruded into sheet that was 0.7 millimeters thick by 3 feet wide.

TABLE 4

	Sample Number 21	22	23	24	25
Regrind	0.362	0.347	0.607	0.996	0.949
TM-75A Coating resin	0.543	0.520	0.260	0.001	0.000
Blue pigment	0.001	0.001	0.001	0.002	0.001
UV stabilizer	0.002	0.002	0.002	0.000	0.002
BDO infused regrind	0.091	0.130	0.130	0.000	0.047
BDO	0.360%	0.520%	0.520%	0.000%	0.190%

The properties of Samples 21-25 are provided in Table 5. The increased amount of BDO or BDO infused regrind decreased the Die C tear strength of the samples.

TABLE 5

	Sample Number 21	22	23	24	25
Melt Index (190 C./8700 grams)	142.6	97.3	82.6	—	36.5
Thick (mm)	0.68~0.70	0.7	0.71	0.74~0.78	0.74
Durometer (Shore A)	86	87	86~87	92~93	93
Specific Gravity (g/cc)	1.205	1.22	1.1925	1.216	1.2036
Tensile Strength (psi)	4483.1	5063.5	8306.0	6778.7	7641.4
Elongation (%)	561.1	489.5	598.0	380.0	422.3
300% (psi)	1504.5	1973.9	1559.2	4143.4	3537.7
Die C tear (lb/in)	494.9	554.3	504.3	575.8	632.1
YI	2.06	1.21	2.43	2.73	2.32

With respect to Samples 26-35, the effect of BDO level on the melt index of a 90A TPU regrind was determined. The test was performed on a 3.5 inch extruder equipped with a melt pump and a 3-roll stand. The product was a sheet that was 3 feet wide by 0.7 mm thick. The BDO was added through the extruder screw. As illustrated in Table 6, the melt index increased with the level of BDO added.

TABLE 6

Sample	Estimated BDO concentration	Melt Index (grams/10 minutes at 190 degrees C. 8700 grams)	Barrel Pressure (psi)
26	0.38	66	2080-2140
27	0.46	77	2050-2120
28	0.5	77	2000-2080
29	0.65	80	1840-1960
30	0.7	82	1730-1810
31	0.74	112	1580
32	~0.88	136	Reduced screw
33	~0.9	150	Reduced screw
34	~0.97	200	Reduced screw
35	~1.11	212	Reduced screw

Additional information on Samples 33 and 34 is provided in Table 7, including the notably increased melt index of the Samples.

TABLE 7

Sample Number	MI	Tensile strain, psi	Failure strain, percent	Modulus at 50%, psi	100%, psi	200%, psi	300%, psi	Die C tear Strength (lb/in)
33	150	7446.5	594.5	1026	1108.5	1318.5	1956	632.5
34	200	6430.5	580	805.5	884	1085	1680.5	660

With respect to Samples 36 to 39 in Table 8, the effect of adding BDO either by using a masterbatch that contained 4% BDO on a 90A ester based TPU regrind that was derived from MDI was compared with the effect of adding BDO by injection through the screw. The feed contained 30% of an ester based TPU derived from MDI with a Shore A hardness of 65A. The balance of the feed was either a 90A ester based regrind derived from MDI or a mix of the 4% BDO master batch with the 90A ester based regrind derived from MDI. The test was performed on a 3.5 inch extruder equipped with a melt pump and a 3-roll stand. The product was a sheet that was 3 feet wide by 0.7 millimeters thick. The BDO was added through the extruder screw. Similar results were obtained using both methods.

TABLE 8

	Sample Number Control	36	37	38	39
Regrind	70%	60%	55%	70%	70%
TB65-AM	30%	30%	30%	30%	30%
4% 1,4 BDO infused regrind added		10%	15%		
BDO added (%)		0.40%	0.60%		
% BDO added by Liquid addition				0.40%	0.60%
Barrel Pressure (psi)	3680	3280	3140	3160	3175
Melt Pump pressure (psi)	680	610	490	390	340
Roll speed	7	7	7	7	7
Roll deposits	none	slight haze	heavy haze	slight haze	heavy haze
Melt Index (grams/10 minutes at 190 degrees C./8700 grams)		49	79	78	91
Molecular Weight (Mw)		120000	88300	84000	80700
Molecular Weight per Number Average Molecular Weight (Mw/Mn)		2.22	2.04	2	1.99
Melt Index (190 C./ 8700 grams)		51	96	104	136

Samples 40 to 45 were prepared according to Table 9 to examine the effect of using different types of glycols. The feed included an ester-based TPU derived from MDI that had a Shore A hardness of 65A, a virgin ester-based TPU derived from MDI, and a 90A ester-based regrind derived from MDI. The starting mixture had a melt index between 8 and 20 grams/10 minutes at 190 degrees C./8700 grams. The glycols were added through the screw. Tripropylene glycol (TPG) and 1,4 cyclohexane dimenthanol (CHDM) produced fewer roll deposits and fumes than glycerin or BDO.

TABLE 9

	hardness Shore A	40	41	42	43	44	45
Virgin 90A TPU	90A	10%	10%	10%	10%	10%	10%
90A TPU regrind	90A	60%	60%	60%	60%	60%	60%
TPU (Coating company TB-65AL)	65A	30%	30%	30%	30%	30%	30%
UV stabilizer		0.25%	0.25%	0.25%	0.25%	0.25%	0.25%
Blue pigment		0.15%	0.15%	0.15%	0.15%	0.15%	0.15%
Extender		None	1,4 BDO	Glycerin	TPG	TPG	CHDM
Extender level			0.60%	0.40%	1.30%	0.60%	0.96%
Barrel Pressure (psi)		2550	1790	1840	1400	1600	
Melt Pump pressure (psi)		620	500	530	380	580	
Screw (RPM)		19.5	19.3	19.0	18.8	18.8	

TABLE 9-continued

	hardness Shore A	40	41	42	43	44	45
Sheet thickness (mm)		0.7	0.7	0.7	0.7	0.7	0.7
Melt Index (grams/10 minutes at 190 degrees C./8700 grams)		25	145	200	390	122	124
Roll fog		none	some	a lot	low	low	low

The foregoing description of the embodiments has been provided for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention. Individual elements or features of a particular embodiment are generally not limited to that particular embodiment, but, where applicable, are interchangeable and can be used in a selected embodiment, even if not specifically shown or described. The same may also be varied in many ways. Such variations are not to be regarded as a departure from the invention, and all such modifications are intended to be included within the scope of the invention.

What is claimed is:

1. A method of preparing an article of footwear or a component of an article of footwear having a surface element, comprising:
- providing scrap polyurethane, wherein the scrap polyurethane has a first melt index and a first tearability;
- mixing the scrap polyurethane with a glycol or polyol additive;
- increasing the first melt index;
- forming a sheet from the polyurethane and glycol or polyol additive mixture;
- applying an area of the sheet to an outer region of an article of footwear or to a component of an article of footwear; and
- forming the surface element, wherein forming the surface element comprises one of:
  - removing the area from the sheet before the applying step or
  - tearing away a perimeter of the sheet around the area.

2. The method of claim **1**, wherein increasing the first melt index further comprises increasing the melt index of the scrap polyurethane by at least three-fold.

3. The method of claim **1**, further comprising melting the scrap polyurethane and glycol or polyol additive together.

4. The method of claim **1**, further comprising recycling the sheet after removing the area from the sheet or recycling the perimeter of the sheet torn away.

5. The method of claim **1**, wherein applying the area of the sheet comprises laminating the area of the sheet onto the footwear or the component of an article of footwear.

6. The method of claim **1**, further comprising adding additives to the scrap polyurethane or to the mixture of the scrap polyurethane with the glycol or polyol additive, such that the surface element has an appearance selected from the group consisting of matte appearance and shiny appearance.

7. The method of claim **1**, wherein the scrap polyurethane comprises scrap polyurethane from a shoe component.

8. The method of claim **1**, wherein forming the surface element comprises tearing away a perimeter of the sheet around the area.

9. The method of claim **8**, further comprising applying the perimeter of the sheet to a region of the article of footwear to form a second surface element.

10. The method of claim **1**, wherein the surface element has a melt index of at least 100 grams/10 minutes at 190 C/8700 grams as provided by ASTM D1238.

11. The method of claim **1**, wherein the glycol or polyol additive comprises butanediol.

12. The method of claim **1**, wherein the surface element comprises less than about 5% of the glycol or polyol additive by weight.

13. A method of preparing an article of apparel or sports equipment with a surface element, comprising:
- providing recycled polyurethane, wherein the recycled polyurethane has a first melt index and a first tearability;
- mixing the recycled polyurethane with a glycol or polyol additive;
- increasing the first melt index;
- forming a sheet from the polyurethane and glycol or polyol additive mixture;
- applying an area of the sheet to an outer region of an article of apparel or sports equipment; and
- forming the surface element, wherein forming the surface element comprises one of:
  - removing the area from the sheet before the applying step or
  - tearing away a perimeter of the sheet around the area.

14. The method of claim **13**, wherein increasing the first melt index comprises increasing the melt index of the recycled polyurethane by at least three-fold.

15. The method of claim **13**, further comprising melting the recycled polyurethane and glycol or polyol additive together.

16. The method of claim **13**, further comprising recycling the sheet after removing the area from the sheet or recycling the perimeter of the sheet torn away.

17. The method of claim **13**, wherein applying the area of the sheet comprises laminating the area of the sheet onto the article of apparel or sports equipment.

18. The method of claim **13**, further comprising adding additives to the recycled polyurethane or to the mixture of the recycled polyurethane with the glycol or polyol additive, such that the surface element has an appearance selected from the group consisting of matte appearance and shiny appearance.

19. The method of claim **13**, wherein the recycled polyurethane comprises scrap polyurethane from a shoe component.

20. The method of claim **13**, wherein forming the surface element comprises tearing away a perimeter of the sheet around the area.

21. The method of claim **20**, further comprising applying the perimeter of the sheet to a region of the article of apparel or sports equipment to form a second surface element.

22. The method of claim **13**, wherein the surface element has a melt index of at least 100 grams/10 minutes at 190 C/8700 grams as provided by ASTM D1238.

23. The method of claim **13**, wherein the glycol or polyol additive comprises butanediol.

24. The method of claim **13**, wherein the surface element comprises less than about 5% of the glycol or polyol additive by weight.

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